~~DRAFT~~FINAL

PRELIMINARY SITE CHARACTERIZATION REPORT

FOR THE
GULFCO MARINE MAINTENANCE
SUPERFUND SITE
FREEPORT, TEXAS

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LIST OF ACRONYMS

AST – Aboveground Storage Tank

BCMCD - Brazoria County Mosquito Control Department

BERA – Baseline Ecological Risk Assessment

COPEC – Contaminant of Potential Ecological Concern

DUS – Data Usability Summary

DW – dry weight

EPA – United States Environmental Protection Agency

ERL – Effects Range Low

FSP – Field Sampling Plan

GRG - Gulfco Restoration Group

kg – kilogram

L - liter

LC_{50} – Median Lethal Concentration

mg - milligram

NOAA – National Oceanic and Atmospheric Administration

NPL – National Priorities List

PAH – Polycyclic Aromatic Hydrocarbon

PSCR - Preliminary Site Characterization Report

QAPP – Quality Assurance Project Plan

RI/FS – Remedial Investigation/Feasibility Study

SAP – Sampling and Analysis Plan

SEM/AVS – Simultaneously Extracted Metals/Acid Volatile Sulfides

SLERA – Screening-Level Ecological Risk Assessment

SMDP – Scientific/Management Decision Point

SOP – Standard Operating Procedure

SOW – Statement of Work

TCEQ – Texas Commission on Environmental Quality

TOC – Total Organic Carbon

USFWS – United States Fish and Wildlife Service

UAO - Unilateral Administrative Order

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. in Freeport, Brazoria County, Texas (the Site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. Pursuant to Paragraph 37(d)(x) of the Statement of Work (SOW) for the RI/FS, included as an Attachment to the UAO, a May 3, 2010 Final Screening Level Ecological Risk Assessment (SLERA) was prepared for the Site (PBW, 2010). The Scientific/Management Decision Point (SMDP) provided in the Final SLERA concluded that the information presented therein indicated a potential for adverse ecological effects to soil- and sediment-dwelling invertebrates, and a more thorough assessment was warranted. The Final Baseline Ecological Risk Assessment (BERA) Work Plan & Sampling and Analysis Plan (SAP) was submitted to the EPA on June 22, 2010 and approved with modifications by the EPA on August 4, 2010. The requested modifications were submitted to the EPA on September 2, 2010 (URS, 2010a).

Following acceptance of the Final BERA Work Plan & SAP (URS, 2010a), a sixty (60) calendar day schedule for sample collection, laboratory analysis, and data validation was required. The BERA Day 60 deliverable, which was submitted to the EPA on October 4, 2010, summarized the field activities, toxicity testing, chemical analyses and data validation. Within thirty (30) calendar days following receipt of all validated laboratory data as provided in the BERA Day 60 deliverable, a Draft Preliminary Site Characterization Report (PSCR) (this report) is to be submitted to the EPA per SOW paragraph 36(d)(i). This PSCR was prepared by URS Corporation (URS) on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy), and The Dow Chemical Company (Dow), collectively, the Gulfco Restoration Group (GRG).

1.1 REPORT PURPOSE

The objective of this PSCR is to describe the activities that have taken place since the submittal of the Nature and Extent Data Report (PBW, 2009), and provide Site data documenting the location and characteristics of the sampling and analysis of the surface soil, surface sediment, and surface water collected in accordance with the Final BERA Work Plan and SAP (URS, 2010a). At this Site, the PSCR is intended to function as the preliminary reference for developing the BERA report. The PSCR also serves to supplement the Nature and Extent Data Report (PBW, 2009). Detailed interpretation of the data described herein will be provided in the BERA report, which will be submitted to the EPA within sixty (60) calendar days following approval of this PSCR.

1.2 SITE BACKGROUND

The Site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The Site consists of approximately 40 acres along the north bank of the Intracoastal Waterway between Oyster Creek (approximately one mile to the east) and the Texas Highway 332 Bridge (approximately one mile to the west). The Site includes approximately 1,200 feet (ft.) of shoreline on the Intracoastal Waterway, the third busiest shipping canal in the US (TxDOT, 2001) that, on the Texas Gulf Coast, extends 423 miles from Port Isabel to West Orange.

Marlin Avenue divides the Site into two primary areas (Figure 2). For the purpose of descriptions in this report, Marlin Avenue is approximated to run due west to east. The property to the north of Marlin Avenue (the North Area) consists of undeveloped land and closed surface impoundments, while the property south of Marlin Avenue (the South Area) was developed for industrial uses with multiple structures, a dry dock, an aboveground storage tank (AST) tank farm, and two barge slips connected to the Intracoastal Waterway.

Adjacent property to the north, west, and east of the North Area is undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intracoastal Waterway bounds the Site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the Site, and 1,000 feet east of the Site.

Some of the North Area is upland created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (USFWS, 2008). The most significant surface features in the North Area are two ponds (the Fresh Water Pond and the Small Pond) and the closed former surface impoundments (Figure 2). The former surface impoundments and the former parking area south of the impoundments and Marlin Avenue comprise the vast majority of the upland area within the North Area.

Field observations during the RI indicate that the North Area wetlands are irregularly flooded with nearly all of the wetland area inundated by surface water that can accumulate to a depth of one foot or more during extreme high tide conditions, storm surge events (such as Hurricane Ike in September 2008), and/or in conjunction with surface flooding of Oyster Creek northeast of the Site. Due to a very low topographic slope and low permeability surface sediments, the wetlands are also very poorly draining and can retain surface water after major rainfall events. Under normal tide conditions and during periods of normal or below normal rainfall, standing water within the wetlands (outside of the two ponds discussed below) is typically limited to a small, irregularly shaped area immediately north of the Fresh Water Pond and similar areas immediately south and southeast of the former surface impoundments. Depending on rainfall and tide conditions, these areas can often be completely dry. ~~As such, given the absence of any appreciable areas of perennial standing water, the wetlands are effectively hydrologically isolated from Oyster Creek, except during intermittent, and typically brief, flooding events.~~

Water in the Fresh Water Pond is approximately 4 to 4.5 feet deep and is relatively brackish (PBW, 2009). This pond appears to be a borrow pit created by the excavation of soil and sediment as suggested by the well-defined pond boundaries and relatively stable water levels. ~~Water levels in the Fresh Water Pond are not influenced by periodic extreme tidal fluctuations as the pond dikes preclude tidal floodwaters in the wetlands from entering the pond, except for extreme storm surge events, such as observed during Hurricane Ike in September 2008.~~

The small irregularly shaped area immediately north of the Fresh Water Pond is a salt panne, a shallow depression that retains sea water for short periods of time such that salt accumulates to high levels over multiple tidal cycles. During the field sampling in August 2010, Benchmark

Ecological Services, Inc measured a surface water salinity of 43 parts per thousand (‰) from this area (EWSW01).

The Small Pond is a very shallow depression located in the eastern corner of the North Area. The Small Pond is not influenced by daily tidal fluctuations and behaves in a manner consistent with the surrounding wetland, i.e., becomes dry during dry weather, but retains water in response to and following rainfall and extreme tidal events. During the field sampling in August 2010, a surface water salinity of 42‰ was measured in the Small Pond (EWSW04), which is also indicative of a salt panne. The surface water salinity from the area south of the impoundments (EWSW03) was approximately 27‰ in September 2010. These salinities were consistent with as-received salinities measured in the laboratory by PBS&J Environmental Toxicology Laboratory (approximately 40‰, 39‰, and 30‰~~%~~ for EWSW01, EWSW04, and EWSW03, respectively; see Appendix B). Surface water was not available from the reference area north of the Site (EWSW02) in August/September 2010. Surface water sampling locations are referenced in Figure 5.

The South Area includes approximately 20 acres of upland that was created from dredged material from the Intracoastal Waterway. The two most significant surface features within the South Area are a Former Dry Dock and the AST Tank Farm. The remainder of the South Area surface consists primarily of former concrete laydown areas, concrete slabs from former Site buildings, gravel roadways and sparsely vegetated open areas with some localized areas of denser brush vegetation, particularly near the southeast corner of the South Area. As described in the Final BERA Problem Formulation (URS, 2010b), the terrestrial portions of the South Area do not contain complete exposure pathways relevant to this assessment and are not considered further in the BERA process.

Aerial spraying of the wetland areas north of Marlin Avenue, including the North Area, for mosquito control has historically been and continues to be performed by the Brazoria County Mosquito Control District and its predecessor agency, the Brazoria County Mosquito Control Department (both referred to hereafter as BCMCD). Aerial spraying for mosquito control has been performed over rural areas in the county since 1957 (Lake Jackson News, 1957). Historically, aerial spraying of a DDT solution in a "clinging light oil base" was performed from altitudes of 50 to 100 feet (Lake Jackson News, 1957). Recently BCMCD has been using Dibrom®, an organophosphate insecticide, with a diesel fuel carrier through a fogging atomizer application (Facts, 2006, 2008a, 2008b), as well as other compounds such as Scourge™, Kontrol 30-30, and Fyfanon® (personal communication between Gary Miller [EPA] and Fran Henderson [BCMCD]). Truck-based spraying has also been performed along Marlin Avenue. Both types of spraying were observed during the performance of Site RI activities.

1.3 REPORT ORGANIZATION

Section 2.0 presents the 2010 field activities and laboratory testing conducted in support of the BERA by geographic area and environmental media. Environmental chemistry results are presented in Appendix A (i.e., a data usability summary [DUS], analytical data summary tables, data validation checklists, and associated laboratory reports from Columbia Analytical Services). Toxicity testing results are provided in Appendix B (i.e., a DUS and associated laboratory reports from PBS&J Environmental Toxicology Laboratory).

2.0 STUDY AREA INVESTIGATION

2.1 INTRODUCTION

Field activities and laboratory testing conducted in support of the BERA in August and September 2010 are described below. Sample collection methods, pore water extraction method, field measurements procedures, laboratory analytical methods, toxicity testing methods, and data validation procedures were specified in the Field Sampling Plan (FSP) (PBW, 2006a), Quality Assurance Project Plan (QAPP) (PBW, 2006b) and/or Final BERA Work Plan & SAP (URS, 2010a). Field activities were also conducted in accordance with the Site-specific Health and Safety Plan (PBW, 2005).

Media Sampling

The initial environmental media sampling began on August 12, 2010 and was completed on August 31, 2010. Samples were analyzed for those contaminants of potential ecological concern (COPECs) listed in the Final BERA Work Plan & SAP (URS, 2010a). Total organic carbon (TOC) data were obtained for all of the sediment samples, and simultaneously extracted metals/acid volatile sulfides (SEM/AVS) and grain size analysis were obtained for the wetland sediments. Data gathered in the field such as water depth, pH, conductivity, temperature, salinity and dissolved oxygen for water and pH, oxygen reduction potential and temperature for sediments are shown on Tables 1 and 2.

Pore water sample EWSED04PW collected on August 27, 2010 could not be analyzed for polycyclic aromatic hydrocarbons (PAHs) due to a laboratory error. Field activities were therefore re-initiated on September 9, 2010 to collect that pore water sample. While the sampling team was present on the Site they evaluated whether sufficient pore water was currently present at EWSED03, EWSED05, and EWSED09 (as well as sufficient surface water from EWSW02 and EWSW03), which had previously been dry. All of these pore water/surface water samples, except for EWSED05PW and EWSW02, were subsequently collected in September 2010. Consistent with the BERA Work Plan & SAP, there were no analytical samples formally archived for this project.

Toxicity Testing

Toxicity testing of sediment was conducted using the 28-day *Neanthes arenaceodentata* and *Leptocheirus plumulosus* whole-sediment tests for both the wetland sediments and Intracoastal Waterway sediments as described in the Final BERA Work Plan & SAP (URS, 2010a). The ~~wetland~~ sediment toxicity testing was conducted from August 25 through September 22, 2010. Responses of test organisms exposed to~~The~~ laboratory control samples for all of the sediment toxicity tests indicated that the test organisms were of acceptable health. Additionally, the reference toxicant tests were within acceptable parameters. The purpose of the laboratory control tests is to determine the validity of the test. The sediment used for the laboratory controls is taken from the York River in Virginia and is processed to remove vegetative matter and then frozen to remove ~~any effects that l~~live indigenous organisms that could ~~may have~~prey upon the test species. ~~remove any unwanted biological entities.~~ The effect of ~~the~~ freezing the sediments on the health of the test organisms is unknown although it likely imparts little uncertainty in the analysis since it is commonly performed and follows standard procedures.

Conducting the 28-day earthworm (*Eisenia fetida*) chronic bioassays for North Area soils, as proposed in the Final BERA Work Plan & SAP (URS, 2010a), was problematic given significantly elevated salinity levels in the six (6) site and three (3) reference/background soil sample locations. When the earthworms were introduced to the North Area soil samples there was an immediate avoidance reaction followed by acute mortality in all of the site and reference/background samples. The elevated salinity levels are believed due to frequent inundation with estuarine water during high water related to storm events. Also, much of the soil/sediment was originally dredge spoils used as fill material. As an alternative to the earthworm bioassays and following discussion and agreement by the EPA, the nine (9) soil samples from this transitional area were treated as sediment by adding synthetic seawater, and exposing the previously identified polychaete *Neanthes arenaceodentata* over a 21-day test duration (growth and survival endpoints). This alternative procedure was approved by the EPA on September 3, 2010. According to the National Oceanic and Atmospheric Administration (NOAA), survival and growth endpoints "are about equal sensitivity" for *Neanthes arenaceodentata* (MacDonald et al, 2003). Polychaetes are more phylogenetically/taxonomically similar to earthworms than amphipods such as *Leptocheirus plumulosus* and are members of the "sediment-ingesting invertebrate" feeding guild that the earthworm was chosen to represent. The 21-day test duration is conservative given the ephemeral nature of the inundation events at the Site. The North Area soil toxicity testing was conducted from September 10 through October 1, 2010.

Similar to the North Area soils, elevated salinity levels measured in August 2010 were also a concern for surface water samples EWSW01 and EWSW04 (with as-received salinities of 40‰ and 39‰, respectively, measured by PBS&J Environmental Toxicology Laboratory), which would likely result in significant stress to the mysid shrimp (*Mysidopsis bahia*) proposed in the Final BERA Work Plan & SAP (URS, 2010a). Appendix B contains all of the toxicity laboratory reports which include presentation of chemistry parameters such as salinity and ammonia measurements. As previously discussed, these elevated salinity levels are indicative of a salt panne. Therefore, the bioassays for the surface water were conducted on brine shrimp (*Artemia salina*), which are better suited for high salinities. There are no standard methods for testing chronic exposures to brine shrimp. Therefore, PBS&J Environmental Toxicology Laboratory developed a standard operating procedure (SOP) for conducting 96-hour acute tests (survival endpoint) by referencing standard procedures for determining toxicity from produced (oilfield) waters (SPE, 1978). This shortened test protocol (from 7 days to 96 hours) is more representative of the transitory nature of the areas being evaluated. Use of the alternative species and test protocol was approved by the EPA on September 3, 2010.

The surface water toxicity tests with *Artemia* were conducted three times between September 16 and October 3, 2010. The initial ~~run~~ test was potentially affected by a laboratory technician using an incorrect food for the test organisms. The second test ~~had~~ exhibited excessive control mortality (failure) (i.e., less than 90% survival of the control) after~~t~~ 48 hours, and the third test was completed with excessive control mortality (failure) after~~t~~ 96 hours.

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2.1.1 Data Validation Process

Appendix A includes the DUS for the chemistry analyses performed by Columbia Analytical Services. Appendix B includes the DUS for the toxicity testing performed by PBS&J Environmental Toxicology Laboratory.

2.1.2 Data Evaluation Process

Chemistry data generated from the BERA sampling and analyses were compared to the previously collected data to evaluate the COPEC concentration gradients. The 2010 BERA data were also compared to the applicable Texas Commission on Environmental Quality (TCEQ) screening benchmarks (TCEQ 2006). Site investigation activities are described by medium and/or area in the sections below. The text below provides a discussion of the COPEC gradients, screening level and/or reference/background exceedances, and corresponding toxicity testing results with supporting tables and figures. For the evaluation of toxicity of Site samples, the most relevant comparison is to results for reference/background ~~results~~stations. This enables the comparison of results between Site-based stations and those reference/background stations that exhibit similar environmental conditions except for the presence of Site COPECs. The statistical analysis of the toxicity results is discussed by study area (Section 2.2 through Section 2.4). Table 3 is a summary of the toxicity testing results for each of the study areas without statistical analysis. Further discussion of the statistical and biological significance of the data will be presented in the BERA.

2.2 NORTH AREA SOIL

North Area soil was evaluated through the collection and analysis of six (6) samples from the Site (NAS01 through NAS06) and three (3) samples from a reference/background area (NAS07 through NAS 09) (see Figure 3 and Figure 1, respectively). All of the soil samples were collected from the 0 to 0.5 foot depth interval. The COPECs for the North Area soil are as follows:

- 4,4'-DDT;
- Aroclor-1254;
- Barium;
- Chromium;
- Copper; and
- Zinc.

2.2.1 Analytical Chemistry Results

Table ~~1~~4 provides a summary of the North Area soil COPEC concentrations used in the original gradient determination (i.e., for the Final BERA Work Plan & SAP [URS, 2010a]) and the soil analytical results generated from implementation of the BERA sampling. Table ~~1~~4 also compares the TCEQ's soil and marine sediment (at EPA's request) benchmarks to the 2010 North Area soil concentrations. Analytical results from 2010 sampling of North Area soils are also presented in Figure 3. Marine sediment benchmarks and soil benchmarks are both potentially applicable conservative screening criteria because parts of the North Area are intermittently flooded due to tides and rainfall.

In general, the 2010 analytical results for North Area soils are lower than the analytical results from the RI/FS. The 2010 soil data show exceedances of the ~~soil~~ benchmarks for barium, chromium, copper and zinc. Detections of zinc exceeded the screening benchmark in five (5) of six (6) Site samples and two (2) of three (3) reference/background samples. ~~TCEQ soil benchmarks were not available for the organics (~~4,4'-DDT and Aroclor-1254 are the only two (2) organic COPECs for this area and their concentrations exceed ~~the~~ EPA's requested comparison with marine sediment benchmarks (Table 4). These benchmarks are effects range low (ERLs) and represent conservative screening criteria (Long et al, 1995). ~~), but these two COPECs were detected at low levels and a concentration gradient was not apparent from the 2010 data.~~ A concentration gradient for the two (2) organic COPEC's was not apparent from the 2010 data. As shown on Table ~~1~~4, concentration gradients were evident for the metals. For example, zinc concentrations in North Area soils ranged from 62.3 to 5,770 milligram/kilogram – Dry Weight (mg/kg-DW), and from 63.1 to 501 mg/kg-DW in reference/background samples. Barium concentrations in North Area soils ranged from 52.2 to 502 mg/kg-DW, and from 172 to 340 mg/kg-DW in reference/background samples.

2.2.2 Toxicity Testing Results

Table ~~1~~4 includes a summary of the soil toxicity testing (bioassay) results. Survival and growth of polychaetes exposed to the control sediment exceeded the test acceptability criteria, indicating that the organisms were suitable for the intended use. For the polychaete *Neanthes arenaceodentata* and the survival endpoint, there were no statistically significant differences

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between the six (6) Site samples and the three (3) reference/background samples. For the primary growth endpoint (i.e., dry weight of surviving organisms divided by the number or surviving organisms) and *Neanthes arenaceodentata*, there were also no statistically significant differences between the six (6) Site samples and the three (3) reference/background locations.

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The results ~~of~~ from the toxicity ~~study~~ tests did~~o~~ not always correlate well with the results of the analytical chemistry. For example, ~~while~~ reference/background-_concentrations of barium and zinc ~~are~~ were elevated in soil sample NAS07, but ~~the~~ survival of *Neanthes arenaceodentata* in that sample was high (92%). Contrastingly, reference/background concentrations of all metal COPECs ~~are~~ were below the TCEQ's soil benchmarks except for chromium, and below all of the marine sediment ~~comparative~~ benchmarks (including chromium) for soil sample NAS09, yet this sample ~~evidenced~~ produced the highest toxicity (60% survival).

2.3 WETLAND SEDIMENT AND SURFACE WATER

Sediment

Wetland sediment was evaluated through the collection and analysis of seven (7) samples from the Site (EWSED01 through EWSED07) and two (2) samples from a reference/background area (EWSED08 and EWSED09), as shown on Figure 4. All of the sediment samples were collected from the 0 to 0.5 foot depth interval. Sediment pore water was extracted and analyzed for COPECs for all but one sediment sample (EWSED05), which was too dry to extract pore water. There was not a formal assessment of benthic invertebrates observed in the samples during the field event; however, polychaete worms and fiddler crabs were observed in all of the wetland sediment sample locations including the reference/background locations. The COPECs for the wetland bulk sediment and pore water are as follows:

- 2-Methylnaphthalene;
- 4,4'-DDT;
- Acenaphthene;
- Acenaphthylene;
- Anthracene;
- Arsenic;
- Benzo(a)anthracene;
- Benzo(a)pyrene;
- Benzo(g,h,i)perylene;
- Chrysene;
- Copper;
- Dibenz(a,h)anthracene;
- Endrin aldehyde;
- Endrin ketone;
- Fluoranthene;
- Fluorene;

- gamma-Chlordane;
- Indeno(1,2,3-cd)pyrene;
- Lead;
- Nickel;
- Phenanthrene;
- Pyrene; and
- Zinc.

Surface Water

Wetland surface water was evaluated through the collection and analysis of three (3) samples from the Site (EWSW01, EWSW03, and EWSW04), as shown on Figure 5. Surface water was not available at reference/background location EWSW02 (Figure 5). In general, surface water in the wetland area ~~is~~ was not consistently present, and when present becomes highly saline as it rapidly evaporates. Surface water salinities measured by Benchmark Ecological Services, Inc. for EWSW01, EWSW03, and EWSW04 were 43‰, 27‰, and 42‰, respectively (Table 1). These salinities were consistent with salinities measured in the laboratory by PBS&J Environmental Toxicology Laboratory (approximately 40‰, 30%, and 39‰ [as received] for EWSW01, EWSW03, and EWSW04, respectively; see Appendix B). The COPECs for the surface water samples were location-specific. For EWSW01, the COPECs consisted of total acrolein and dissolved copper. The COPEC for EWSW03 was dissolved copper and the COPEC for EWSW04 was dissolved silver.

2.3.1 Analytical Chemistry Results

Sediment

Table ~~2~~ 5 provides a summary of the wetland sediment data used in the original gradient determination (i.e., for the Final BERA Work Plan & SAP [URS, 2010a]) and the wetland sediment analytical results generated from the implementation of the BERA sampling. Table ~~2~~ 5 also compares the TCEQ's marine sediment benchmarks and marine surface water benchmarks to the 2010 bulk sediment and pore water data, respectively. Analytical results from 2010 sampling of wetland sediment are also presented in Figure 4.

In general, the 2010 analytical results for wetland sediments ~~are~~ were lower than the analytical results from the RI/FS. There were exceedances of the sediment benchmarks for several individual PAHs and metals (lead, nickel and zinc). The only exceedances of surface water benchmarks from Site sediment pore water were for endrin aldehyde, endrin ketone, copper, and zinc. The only exceedances of either sediment or surface water benchmarks in the reference/background samples were 4,4'-DDT in sediment; and 4,4'-DDT, endrin aldehyde, and nickel in pore water. As shown on Table ~~2~~5, concentration gradients were identified for the majority of the COPECs. For example, zinc concentrations in wetland sediments ranged from 70.1 to 959 mg/kg-DW in Site samples and from 68.3 to 94.3 mg/kg-DW in reference/background samples. Copper concentrations in wetland sediments ranged from 13.3 to 30.7 mg/kg-DW in Site samples and from 11.7 to 15.8 mg/kg-DW in reference/background samples. Copper concentrations in sediment pore water ranged from non-detect to 0.00702 milligram/Liter (mg/L) in Site samples and from non-detect to 0.00137 mg/L in reference/background samples.

Detailed information on sediment grain size and SEM/AVS are presented on Table ~~3~~6 and Table ~~4~~7, respectively. The SEM/AVS ratios presented in Table ~~4~~7 are all above 1.0, except for EWSED08 (with an SEM/AVS ratio of 0.157), which indicates that sufficient sulfide ~~is~~ was generally not present to completely form insoluble metal sulfides with cadmium, copper, lead, nickel, and zinc. However, sediment organic carbon can also bind the free metals and reduce their availability to aquatic organisms. The ratio of "excess" SEM to the fraction organic carbon content of sediment ~~is~~ was below 130 $\mu mol/g_{oc}$ (the concentration predicted to be non-toxic by the EPA [2005]) for six (6) of seven (7) Site samples. Also, the remaining Site sample (EWSED06) had~~s~~ an organic carbon-normalized excess SEM ratio of 168, which is at the low end of the range where the prediction of toxicity is uncertain (130 to 3,000 $\mu mol/g_{oc}$; EPA, 2005). The sediment grain size data presented in Table ~~3~~6 are fairly consistent between locations, except for the relatively high fraction of gravel and low fraction of clay found at EWSED02 and EWSED03 as compared to the opposite situation (low fraction of gravel and high fraction of clay) at EWSED01, EWSED04, EWSED06, EWSED07, and EWSED09.

Surface Water

Table ~~5~~8 provides a summary of the wetland surface water results considered in the original gradient determination (i.e., for the Final BERA Work Plan & SAP [URS, 2010a]) and the wetland surface water analytical results generated from the implementation of the BERA sampling. Analytical results from 2010 sampling of wetland surface water are also presented in Figure 5. The reference/background location EWSW02 was dry and could not be sampled for surface water. The only exceedance of a surface water benchmark was for dissolved copper at EWSW03.

2.3.2 Toxicity Testing Results

Sediment

Table ~~2~~5 includes a summary of the wetland sediment toxicity testing (bioassay) results. Survival and growth of polychaetes and amphipods exposed to the control sediment exceeded the test acceptability criteria, indicating that the organisms were suitable for the intended use. For the polychaete ***Neanthes arenaceodentata*** and the **survival endpoint**, there were no statistically significant differences between the seven (7) Site samples (EWSED01 through EWSED07) and the two (2) reference/background samples (EWSED08 and EWSED09). For the primary **growth endpoint** and ***Neanthes arenaceodentata***, there were also no statistically significant differences between the seven (7) Site samples and the two (2) reference/background samples.

For the amphipod ***Leptocheirus plumulosus*** and the **survival endpoint**, there were no statistically significant differences between seven (7) Site samples (EWSED01 through EWSED07) and the two (2) reference/background locations (EWSED08 and EWSED09). For the **growth endpoint** and ***Leptocheirus plumulosus***, there were also no statistically significant differences between the seven (7) Site samples and the two (2) reference/background locations. Insufficient offspring were available for a statistical analysis of reproduction as an endpoint.

The results of the toxicity study did~~e~~ not always correlate well with the results of the analytical chemistry. For example, a zinc concentration of 115 mg/kg-DW at EWSED01 was associated with *Leptocheirus plumulosus* survival of 35%, while a zinc concentration of 595 mg/kg-DW at EWSED05 was associated with *Leptocheirus plumulosus* survival of 38%. These results serve to illustrate the fact that toxicity test organism responses reflect exposure to the full balance of potential stressors, not individual analytes. These stressors include Site COPECs and other types of -stressors (e.g., elevated salinities~~, ammonia~~)) which can exert independent and collective effects. Thus, caution regarding co-occurrence screening benchmarks should be exercised when interpreting such data.

Surface Water

Table ~~5~~-8 includes a summary of the wetland surface water toxicity testing (bioassay) results for ***Artemia salina***. The surface water toxicity tests were conducted three times between September 16 and October 3, 2010. The initial run was potentially affected by a laboratory technician using an incorrect food for the test organisms. The second test had control failure (i.e., less than 90% survival of the control) at 48 hours, and the third test was completed with control failure at 96 hours.

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EWSW01 and EWSW04 showed no evidence of acute toxicity since survival in the undiluted samples ~~were~~ was ≥ 80% for all test durations where the corresponding control survival was ≥ 90%. EWSW03 was found to be non-toxic in test runs 1 and 2 (survival in the undiluted sample was ≥ 80% for all test durations where the corresponding control survival was ≥ 90%). In test run 3, a concentration-related mortality response was observed for EWSW03. The corresponding median lethal concentrations (LC_{50}s) ~~are~~ were as follows:

- 24 hr = 30.7%;
- 48 hr = 10.6%; and
- 72 hr = 6.2%.

While the mortality response for EWSW03 in test run 3 ~~is~~ was consistent with the detection of copper at a concentration above the TCEQ surface water benchmark (0.00854 vs. 0.00360 mg/L), the magnitude of the exceedance ~~is~~ was not consistent with the observed mortality in test run 3, and ~~is~~ was not consistent with the absence of toxicity in the first two runs.

2.4 INTRACOASTAL WATERWAY SEDIMENT

Intracoastal Waterway sediment was evaluated through the collection and analysis of five (5) samples from the Site (EIWSED01 through EIWSED05) and two (2) samples from a reference/background area (EIWSED06 and EIWSED07), as shown on Figure 6 and Figure 7, respectively. All of the sediment samples were collected from the 0 to 0.5 foot depth interval. There was not a formal assessment of benthic invertebrates observed in the samples during the field event; however, benthic invertebrates were observed in all of the Intracoastal Waterway sediment samples including the reference/background samples. The most abundant organisms appeared to be polychaete worms (i.e., *Neanthes*). Additionally, mud crabs and snapping shrimp were observed in some of the sediment samples by the field crew. Sediment pore water was extracted from all seven (7) locations and analyzed for Site COPECS. The COPECs for the Intracoastal Waterway bulk sediment and pore water are as follows:

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- 4,4'-DDT;
- Acenaphthene;
- Benzo(a)anthracene;
- Chrysene
- Dibenz(a,h)anthracene;
- Fluoranthene;
- Fluorene;
- Hexachlorobenzene;
- Phenanthrene; and
- Pyrene.

2.4.1 Analytical Chemistry Results

Table ~~6~~9 provides a summary of the Intracoastal Waterway sediment data used in the original gradient determination (i.e., for the Final BERA Work Plan & SAP [URS, 2010a]) and the Intracoastal Waterway sediment analytical results generated from implementation of the BERA sampling. Table ~~6~~9 also compares the TCEQ's marine sediment benchmarks and marine surface water benchmarks to the 2010 bulk sediment and pore water data, respectively. Analytical results from 2010 sampling of Intracoastal Waterway sediment and associated reference/background sediment are presented in Figure 6 and Figure 7, respectively.

In general, the 2010 analytical results for Intracoastal Waterway sediments ~~are~~ were lower than the analytical results from the RI/FS. There were no exceedances of the marine surface water benchmarks in sediment pore water. The only exceedances of sediment benchmarks were in sample EIWSED02 (4,4'-DDT, acenaphthene, and fluorene). As shown on Table ~~6~~9, concentration gradients were identified for the majority of Site COPECs. For example, fluoranthene concentrations in Intracoastal Waterway sediments ranged from 0.074 to 0.52 mg/kg-DW in Site samples and from 0.018 to 0.0019 mg/kg-DW in reference/background samples.

2.4.2 Toxicity Testing Results

Table ~~6~~9 includes a summary of the Intracoastal Waterway sediment toxicity testing (bioassay) results. Survival and growth of polychaetes and amphipods exposed to the control sediment exceeded the test acceptability criteria, indicating that the organisms were suitable for the intended use. For the polychaete ***Neanthes arenaceodentata*** and the **survival endpoint,** there were no statistically significant differences between the five (5) Site samples (EIWSED01 through EIWSED05) and the two (2) reference/background samples (EIWSED06 and EIWSED07). For the **growth endpoint** and ***Neanthes arenaceodentata*,** there were also no statistically significant differences between the five (5) Site samples and the two (2) reference/background locations.

For the amphipod ***Leptocheirus plumulosus*** and the **survival endpoint,** there were no statistically significant differences between the five (5) Site samples (EIWSED01 through EIWSED05) and the two (2) reference/background samples (EIWSED06 and EIWSED07). For the **growth endpoint** and ***Leptocheirus plumulosus*,** there were also no statistically significant differences between the five (5) Site samples and the two (2) reference/background locations. Insufficient offspring were available for a statistical analysis of reproduction.

The results of the toxicity study do not always correlate well with the results of the analytical chemistry. For example, a fluoranthene concentration of 0.52 mg/kg-DW at EIWSED02 was associated with ***Leptocheirus plumulosus*** survival of 64%, while a lesser (i.e., more than seven-fold) fluoranthene concentration of 0.074 mg/kg-DW at EIWSED04 was associated with ***Leptocheirus plumulosus*** survival of 42%.

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2.5 PRELIMINARY CONCLUSIONS

The data collected to support the BERA are of adequate quality and quantity to accurately address the ecological risk questions described in the Final BERA Work Plan & SAP (URS, 2010a):

1. Does exposure to COPECs in soil adversely affect the abundance, diversity, productivity, and function of the soil invertebrate community?

2. Does exposure to COPECs in bulk sediment and pore water adversely affect the abundance, diversity, productivity and function of the benthic invertebrate community?

3. Does exposure to COPECs in surface water adversely affect the abundance, diversity, productivity and function of the fish community?

Overall the data met the data quality objectives identified in the Final BERA Work Plan & SAP (URS, 2010a) and are adequate for evaluation and risk characterization in the BERA.

As described in the Final BERA Work Plan & SAP (URS, 2010a), the principal assumption of the field study "is that "the lines of evidence generated by the field study will be sufficient to satisfy the assessment endpoints and that the data will be an adequate indicator of toxicity associated with COPECs present in the Site sediments" (URS, 2010a). Other assumptions included in the Final BERA Work Plan & SAP (URS, 2010a) are as follows:

- The results of the toxicity testing will be indicative of the effects of the COPECs;
- The pore water analytical results are representative of bioavailability;
- Bulk sediment analytical results coupled with TOC and SEM/AVS analyses are representative of bioavailability; and
- Differences in the toxicity test results between the reference/background samples and Site samples are a result of differences in concentrations or bioavailability of the COPECs in the media.

North Area Soils

The testing of *Neanthes arenaceodentata* over a 21-day exposure period showed no statistically significant differences between the North Area soil samples and the reference/background samples. As summarized on Table ~~1~~3 and Table ~~7~~4, survival of the six (6) Site samples ranged from 76% to 96% and survival of the three (3) reference/background samples ranged from 60% to 92%. The growth data showed a similar relationship between the Site and reference/background samples. The results of the toxicity study did~~o~~ not always correlate well with the results of the analytical chemistry as compared to screening benchmarks. For example, while reference/background concentrations of barium and zinc ~~are~~ were elevated in soil sample NAS07, the survival of *Neanthes arenaceodentata* in that sample was high (92%). Contrastingly, reference/background concentrations of all metal COPECs except chromium ~~are~~ were below the TCEQ's soil benchmarks~~, for soi~~ for ~~1~~ sample NAS09, yet this sample ~~evidenced~~ produced the highest toxicity (60%). Note that the chromium detected in sample NAS09 (13.3 mg/kg) is greater than the soil benchmark of 0.4 mg/kg, but well below the marine sediment benchmark of 81 mg/kg (Table 4).

Wetland Sediment

Toxicity testing of the wetland sediment was conducted using the 28-day *Neanthes arenaceodentata* and *Leptocheirus plumulosus* whole-sediment tests. Table ~~2~~3 and Table ~~7~~5 summarize the toxicity test results for these samples. There were no statistically significant differences between the wetland sediment samples and the reference/background samples. The comparison of bulk sediment and sediment pore water concentrations to screening benchmarks (Table ~~2~~5) generally indicates a relatively low bioavailability and low potential for sediment toxicity. The ratio of "excess" SEM to the fraction organic carbon content of sediment (Table ~~4~~7) ~~also~~ indicates low bioavailability of metal COPECs and supports the observation of ~~notion that cadmium, copper, lead, nickel, and zinc have a~~ low potential ~~for~~ to produce sediment toxicity. The results of the toxicity study do not always correlate well with the results of the analytical chemistry when compared to benchmarks.

Wetland Surface Water

The only exceedance of a surface water benchmark was for dissolved copper at EWSW03 (0.00854 mg/L versus 0.0036 mg/L; Table ~~5~~8). While the exceedance may correlate to the toxicity testing of ***Artemia salina*** (where a concentration-related mortality response was observed for this sample in test run 3), the magnitude of the exceedance (i.e., about two-fold) does not seem to be consistent with the observed mortality. Uncertainties associated with the high saline conditions at the Site and the ephemeral nature of the surface water present will be discussed in the BERA.

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Intracoastal Waterway Sediment

Toxicity testing of the Intracoastal Waterway sediment was conducted using the 28-day *Neanthes arenaceodentata* and *Leptocheirus plumulosus* whole-sediment tests. Table ~~6~~ 3 and Table ~~7~~ 9 summarize the toxicity test results for these samples. There were no statistically significant differences between the Intracoastal Waterway sediment samples and the reference/background samples. The comparison of bulk sediment and sediment pore water concentrations to screening benchmarks (Table ~~6~~9) indicates a low potential for sediment toxicity.

2.6 POTENTIAL SOURCES OF UNCERTAINTY

The BERA Report (to be developed after EPA approval of the Final PSCR) will include a more detailed summary of the uncertainties to be considered. This section presents a preliminary assessment of the potential sources of uncertainty that will be expanded in the BERA Report. These preliminary uncertainties include:

- Potential uncertainties associated with the nature and extent of the Site COPECs and the BERA sampling locations are minimal since the COPECs were selected through the conservative SLERA process and the sample locations for the BERA were based on the previously collected samples.
- COPECs were initially determined using data obtained for the RI in 2008 and presented in the Nature and Extent Data Report (PWB, 2009) and evaluated in the Final SLERA (PWB, 2010). These data were also used to develop the COPEC concentration gradient described in the Final BERA Work Plan & SAP (URS, 2010a). Between the time of the RI sampling in 2008 and the BERA sampling in 2010 there has been periodic

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flooding of the wetland area in addition to the landfall of Hurricane Ike in September 2008. The impact to the concentrations of the COPECs is unknown.

- The possibility that naturally-occurring benthic invertebrates might have influenced the test organisms through predation or competition for food is unlikely. Records from PBS&J Environmental Toxicology Laboratory document that no invertebrates other than the test organisms were observed in the samples after test termination. Additionally, all of the samples were press-sieved (thereby likely eliminating predators) except for the heavy clay North Area soils that were hydrated for the 21-day polychaete test.

- The uncertainties associated with the performance of the laboratory controls are minimal. All of the laboratory controls showed acceptable survival and growth. The average survival of *Neanthes arenaceodentata* in the controls ranged from 96% to 100%, whereas the average survival of *Leptocheirus plumulosus* in the controls was 81.5%. These results indicate that *Leptocheirus plumulosus* was more sensitive than *Neanthes arenaceodentata* to test conditions.

- Reference/background locations were utilized in the BERA for the study areas and media. The purpose of the reference/background samples was to be able to distinguish toxicity effects that would occur without the presence of the Site COPECs as defined by the SLERA. All of the results for the analytical chemistry and toxicity endpoints in Site samples should be considered in relation to the results from the reference/background samples. Both natural processes and anthropogenic processes could result in the presence of various stressors not associated with the Site:
  - Natural processes could include deposition of naturally-occurring metallic minerals in sediments (e.g., silicon, calcium, sodium, potassium, phosphorus, carbonates, or sulfates); and
  - Anthropogenic processes include deposition of chemicals from internal combustion engine exhaust, dredge spoil, mosquito spraying, highway runoff, and flood events. Marine engines have limited emissions controls for air emissions and no controls for particulate matter (EPA, 2010). Their emissions are therefore similar to what would be found on a busy highway.

- The results of the toxicity studies are not always well correlated to the results of the analytical chemistry when compared to benchmarks. For example, while reference/background concentrations of barium and zinc are elevated in soil sample NAS07, the survival of *Neanthes arenaceodentata* in that sample was high (92%).

Contrastingly, reference/background concentrations of all metal COPECs are below the TCEQ's soil benchmarks for soil sample NAS09, yet this sample evidenced the highest toxicity (60%).

- There is uncertainty with the application of the 96-hour time frame for the evaluation of *Artemia salina* (brine shrimp). As previously discussed, the BERA Work Plan & SAP (URS, 2010a) proposed the use of mysid shrimp as the test species, but when the surface waters were received at the laboratory the measured salinities were elevated beyond a level appropriate for the mysid shrimp. *Artemia* has an extreme euryhaline character. Its tolerance to salinity ranges from brackish water to saturated brines (Vanhaecke *et al.*, 1981). Numerous test methods using *Artemia* are for 24 to 48 hour exposures (SPE, 1978). The exposure period of 24 hours is usually associated with the testing of freshly hatched individuals (nauplii). For the surface water toxicity testing completed for the Site, control failure did not occur at 24 hours (for all 3 test runs) or at 48 hours (from test runs 1 and 3).

- There is uncertainty in the LC_{50} results for EWSW-03. The level of acute mortality in EWSW-03 does not match the slight benchmark exceedance due to a lack of reproducibility in the Artemia survival for this sample. The 100% surface water samples (i.e., undiluted) for EWSW-01 and EWSW-04 exhibited survival rates of 97% and 99% in the first test, respectively, and 80% and 96% in the third test, respectively, after 48-hours, indicating reproducibility in the tests. Conversely, the 100% surface water sample (undiluted) for EWSW-03 exhibited survival rates of 100% and 0% in the first and third tests, indicating irreproducibility in the test.

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